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PROJECT
CHECO
SOUTHEAST ASIA
REPORT

11801

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PROJECT
Contemporary
Historical
Evaluation of
Combat
Operations
REPORT

IGLOO WHITE

(INITIAL PHASE)

31 JULY 1968

HQ PACAF

Directorate, Tactical Evaluation
CHECO Division

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Prepared by:

Colonel Jesse C. Gatlin

Project CHECO
7th AF, DOAC

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DEPARTMENT OF THE AIR FORCE
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REPLY TO ATTN OF: DOTEC

31 July 1968

SUBJECT: Project CHECO Report, "IGLOO WHITE, (Initial Phase)" (U)

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FOR THE COMMANDER IN CHIEF

WARREN H. PETERSON, Colonel, USAF
Chief, CHECO Division
Directorate, Tactical Evaluation
DCS/Operations

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AU(ASI-ASAD) .	1Cy (60)
AU(AUL3T-66-7)	1Cy (61)
AU(ACSC)	1Cy (62)
ADC(ADODC) ...	1Cy (63)
ADC(ADOOP) ...	2Cys(64&65)
ADC(ADLPP) ...	2Cys(66&67)
TAC(DO-O)	1Cy (68)
TAC(DPL)	2Cys(69&70)
TAC(DOTS)	1Cy (71)
TAC(DORQ)	1Cy (72)
TAC(DI)	1Cy (73)
MAC(MAFOI) ...	1Cy (74)
MAC(MAODC) ...	1Cy (75)
MAC(MAOCO) ...	1Cy (76)
AFSC(SCL)	8Cys(77-84)
AFSC(SCO)	2Cys(85&86)
AFLC(MCO)	1Cy (87)
AFLC(MCF)	1Cy (88)
ATC(ATXDC) ...	1Cy (89)
SAC(DO)	1Cy (90)
SAC(DPL)	1Cy (91)
SAC(DXI)	1Cy (92)
SAC(SCIH)	1Cy (93)
SAC(OA)	1Cy (94)
USAFA(OI)	1Cy (95)
USAFA(DFH) ...	1Cy (96)
USAFE(OPL) ...	2Cys(97&98)
USAFSO(NDI) ..	1Cy (99)
USAFSO(BIOH) .	1Cy (100)
USAFSS(ODC) ..	2Cys(101&102)

OTHERS

9AF(DO)	1Cy (103)
12AF(DI)	1Cy (104)
19AF(DA-C) ...	1Cy (105)
USAFAGOS	1Cy (106)
USAFSAWC(DO) .	1Cy (107)
USAFTAWC(DA) .	1Cy (108)
USAFTARC(DI) .	1Cy (109)
USAFTALC(DA) .	1Cy (110)
USAFTFWC(CRCD)	1Cy (111)
FTD(TDPI)	1Cy (112)
AFAITC	1Cy (113)
SRAFREP(SWC)..	1Cy (114)

PACAF

C	1Cy (115)
DP	1Cy (116)
DI	1Cy (117)
DO	1Cy (118)
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5AF(DOP)	1Cy (121)
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3TFW	1Cy (134)
8TFW	1Cy (135)
12TFW	1Cy (136)
14ACW	1Cy (137)
31TFW	1Cy (138)
35TFW	1Cy (139)
37TFW	1Cy (140)
56ACW	1Cy (141)
315ACW	1Cy (142)
355TFW	1Cy (143)
366TFW	1Cy (144)
388TFW	1Cy (145)
432TRW	1Cy (146)
460TRW	1Cy (147)
483TAW	1Cy (148)
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FOREWORD

Exceedingly costly and complex, the MUSCLE SHOALS program (changed to IGLOO WHITE in June 1968) required dynamic planning of many agencies of the Department of Defense. "IGLOO WHITE (Initial Phase)" provides an overview of its contribution to the interdiction effort in Laos.

From conception to eventual deployment in Southeast Asia, the mission of the MUSCLE SHOALS program, the air-supported anti-infiltration subsystem, was to supplement interdiction of the flow of men and materiel from North Vietnam into South Vietnam.

This study projects the identity and scope of Phase I, MUSCLE SHOALS; operational resources and equipment necessary to make this program function; and technological advances and problems encountered. It covers the initial operational capability dates--1 December 1967 for the MUD RIVER antivehicular subsystem; 20 January 1968 for the DUMP TRUCK antipersonnel subsystem--through 31 March 1968.

CHAPTER I

MUSCLE SHOALS CONCEPT

The program known by the nickname MUSCLE SHOALS was begun officially on 16 September 1966, by a decision of the Secretary of Defense, Robert S. McNamara, to develop a system to interdict North Vietnamese infiltration into South Vietnam. Initially this program was nicknamed PRACTICE NINE and included two major closely related systems: (1) A strong point/obstacle subsystem to be deployed in a line across Vietnam just below the demilitarized zone extending inland from the seacoast; and (2) an air-supported anti-infiltration subsystem extending westward from the strong point/obstacle subsystem into central Laos to include what popularly was known as the Ho Chi Minh Trail, a network of roads and trails leading southward from North Vietnam through central and eastern Laos into South Vietnam. Mr. McNamara established a joint task force known as the Defense Communications Planning Group (DCPG), under the command of Lt. Gen. A. D. Starbird, U.S. Army, to plan and develop the system. By the end of 1966, this group had prepared a program definition plan which resulted in decisions by the Secretary of Defense to budget funds for the program.[1/]

Evaluation of Nicknames

The nicknames given to the system changed several times, because of partial compromises of their classified meanings. The first change occurred on 14 June 1967, when PRACTICE NINE was changed to ILLINOIS CITY. One month later, on 15 July 1967, ILLINOIS CITY was changed to DYE MARKER. Then on 8 September 1967, after the Secretary of Defense released information to the

public which implied the construction of a strong point obstacle system south of the demilitarized zone, the Defense Communications Planning Group decided to give separate nicknames to each of the two major closely related systems: DYE MARKER remained the name of only the ground obstacle sub-system, and MUSCLE SHOALS was the new nickname for the air-supported sub-system in central and eastern Laos, and in the western portion of South Vietnam, just below the demilitarized zone. At the same time, this air-supported system, collectively know as MUSCLE SHOALS, was further subdivided into an antipersonnel subsystem called DUMP TRUCK, and an antivehicular sub-system called MUD RIVER.[2/]

Despite the policy of strict secrecy for MUSCLE SHOALS, two references to the system appeared in the International Press. One national magazine referred to the "barrier" in these words: "Among the proposals that the Institute for Defense Analysis-sponsored group finally submitted to the Department of Defense was the concept of a barrier of electronic, acoustic, and pressure sensors and other devices to detect enemy movement...A barrier of sorts has been built..."

An English-language edition of <u>Bangkok World</u> carried a front-page news story which quoted an un-named American "spokesman":

> *"...The U. S. is 'seeding' central and southern Laos with Top Secret electronic sensors that detect the movement of Communist trucks and troops down the Ho Chi Minh trail toward South Vietnam.*
>
> *"The concealed sensors transmit electronic signals to U. S. jets, giving the approximate area of the Communist activity, the sources said. American planes*

> *bomb the suspected positions.*
>
> *"So far, the process is 'yielding promising results' in cutting down the flow of men and supplies from North Vietnam through Laos into South Vietnam.*
>
> *"The sensors are planted in areas along the Ho Chi Minh trail where there are no friendly troops, so the detectors would not mistakenly call in air raids on Laotian soldiers."*

Functional Components

This report concerns only the portion of the initially conceived system known as MUSCLE SHOALS--that is, with the DUMP TRUCK antipersonnel subsystem and the MUD RIVER antivehicular subsystem. The strong point obstacle subsystem, although not discussed, still retained the nickname DYE MARKER.

Essentially the MUSCLE SHOALS system consisted of three functional components: (1) sensing devices which were emplaced across, along, or within suspected routes of infiltration to detect enemy foot or vehicular movement, together with munitions to inhibit such movement; (2) orbiting aircraft which received signals from these sensors, amplified them, and retransmitted them; and (3) an Infiltration Surveillance Center (ISC) which received the transmitted signals from the aircraft and analyzed them to produce reliable intelligence data for planning interdiction operations against the enemy. As initially conceived in the program plan published by DCPG in October 1967, the system included a strike component consisting of "such elements as FAC aircraft, strike aircraft and the SEA Integrated Air Control System."[3/] But, as will be discussed later, the command and control of these strike forces and of those aircraft needed to implant and monitor sensing

devices and related munitions were not clearly spelled out in the initial plan, and became a subject of debate and concern among those charged with operating the system in the field.

Program Objective

One thing is certain: MUSCLE SHOALS was expected to produce information on enemy vehicular and personnel movements reliably enough and quickly enough to be used for directing immediate strikes by attack aircraft against these targets as they were identified and located. It was conceived as a real-time intelligence source which would result in rapid target acquisition and attack by airstrike forces. Therefore a central and crucial portion of the system was to be the Infiltration Surveillance Center, a complex of highly technical electronic equipment and highly trained personnel to operate it, located at Nakhon Phanom Air Base in northeastern Thailand.

To insure centralized control of this complex and its related administrative and operational requirements, Brig. Gen. William P. McBride assumed command in October 1967, of a Seventh Air Force group known as Task Force Alpha (TFA). Their main responsibility became the operation of the installation at Nakhon Phanom known by the nickname DUTCH MILL. [4/] Here at this installation was centered the brain of the MUSCLE SHOALS program. Here the raw data obtained from the sensing devices were assembled, analyzed, and stored. Here decisions were made on the validity of sensor data and on information to be passed on to strike forces. In short, this nerve center was a crucial focal point in the operation of the MUSCLE SHOALS program through March 1968. Because of these facts, an understanding of the tasks

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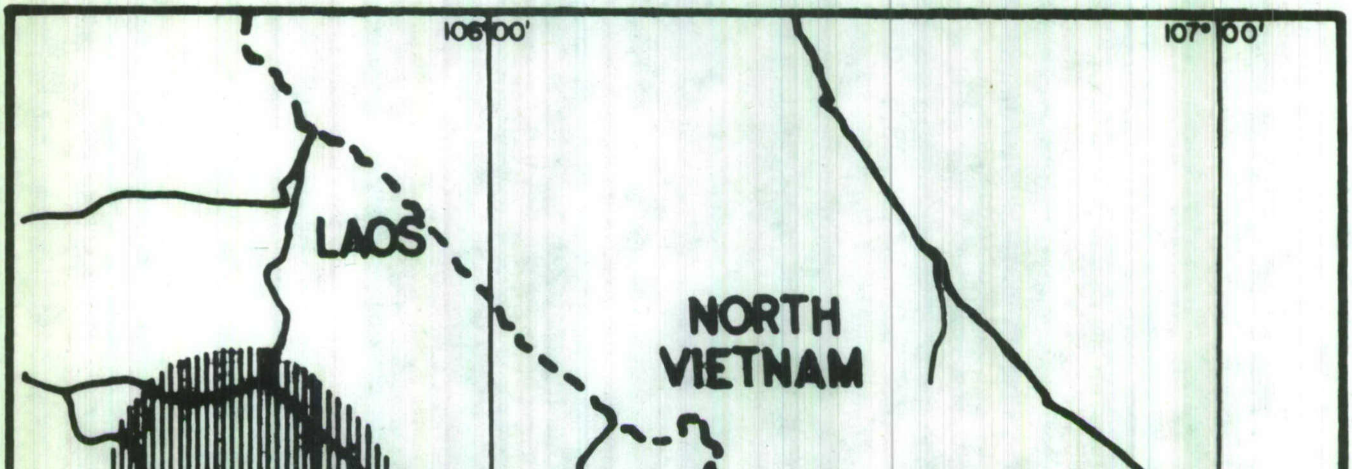

ANTI INFILTRATION
SUBSYSTEMS

FIGURE 1

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which DUTCH MILL performed, the accomplishments it achieved, and the problems it encountered was essential to appreciate the operational contribution of the MUSCLE SHOALS program to the interdiction effort it was designed to supplement.

DCPG Plan for Deployment

Before discussing the operational components and functional details of MUSCLE SHOALS, a clear statement of its original concept and mission is appropriate. The DCPG Program Plan, dated 25 October 1967, after a brief summary of the extent of North Vietnamese infiltration into South Vietnam through the Demilitarized Zone and Laos, states that the objective of the anti-infiltration systems--including DYE MARKER and MUSCLE SHOALS--was "large-scale, selective interdiction of this enemy resupply and support effort ... to reduce his effectiveness as a fighting force." [5/] The plan also states the system "augments on-going anti-infiltration efforts and provides capabilities in areas where only limited interdiction efforts have been carried out to date". [6/] It further locates the antipersonnel subsystem in eastern Laos and western South Vietnam, and the antivehicular subsystem in central Laos (Fig. 1).

This statement of the operational mission included "large scale, selective interdiction" and therefore implied a relatively high priority in assignment of strike resources to the interdiction effort in the areas covered by the plan.

7AF Plan and Operation Order

The Seventh Air Force Operation Plan (481-68), dated 10 August 1967, emphasized that MUSCLE SHOALS was "designed to augment the current overall interdiction program, not substitute for it", and stressed that the system "should not be viewed as a panacea or a final solution to the interdiction problem." 7/ As Gen. William W. Momyer, Seventh Air Force Commander, stressed in a statement to his staff early in March 1968, MUSCLE SHOALS was to furnish another set of eyes to supplement those visual and mechanized means already used to detect and strike enemy infiltration. 8/

As the operational command responsible for actually operating and using the data generated by MUSCLE SHOALS, Seventh Air Force officially conceived of the system as basically an intelligence gathering device, and not as a control agency to direct aircraft strikes on specific targets. The command and control of all aircraft sorties involved in the program were nominally retained in the 7AF Tactical Air Control Center (TACC) at Tan Son Nhut Air Base. In practice they were delegated to the Airborne Battlefield Command and Control Center (ABCCC), an airborne extension of the TACC which flew from Udorn RTAFB, Thailand, to orbits which permitted control of air traffic throughout that portion of the 7AF interdiction area, which includes the MUSCLE SHOALS area.

Accordingly, the 7AF Operation Order (515-68) designated specific tasks and forces for the MUSCLE SHOALS program, with General McBride assigned as the Commander, Task Force Alpha. His responsibility was to control the DUTCH MILL complex at Nakhon Phanom, from the technical development aspect

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AIR SUPPORTED INFILTRATION INTERDICTION CONCEPT

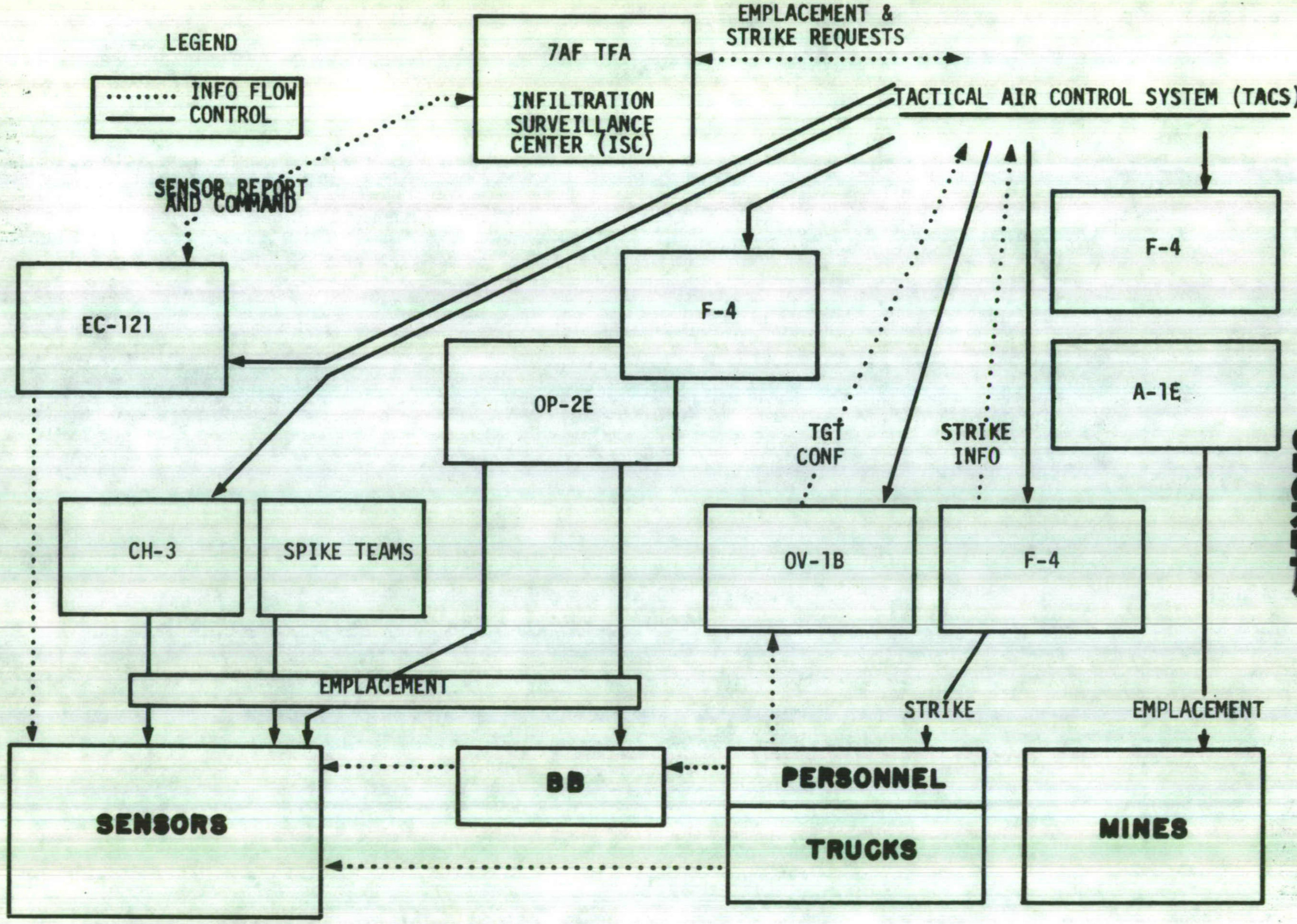

FIGURE 2

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of the system and its intelligence impact to 7AF.

The aircraft needed to reconnoiter potential and actual sensor sites, to implant and orbit sensors, and to sow the mines and munitions associated with the sensor fields were ordered to their flight missions directly from the 7AF Tactical Air Control Center (TACC) at Tan Son Nhut, Vietnam. They were directed, in case of FAC reconnaissance and subsequent airstrikes, by the Airborne Battlefield Command and Control Center.[9] An important implication of this centralized control over FAC reconnaissance of sensor-developed targets, as well as the impact on other aspects of the MUSCLE SHOALS operation, will be discussed later in this report.

CHAPTER II

HOW MUSCLE SHOALS OPERATED

The basic operational concept and the chief links in the MUSCLE SHOALS system are illustrated in Figure 2. The plan was to have the antivehicular subsystem (MUD RIVER) begin operations on 1 November 1967. Truck traffic would be detected by air-emplaced acoustic and seismic sensors which pick up the noise or vertical earth-shock produced by vehicular movement along roads and trails of central Laos. Gravel or Dragontooth mines, capable of injuring personnel and damaging truck tires, would be sown along these routes to immobilize vehicles and inflict casualties among accompanying personnel.[1]

In the antipersonnel area (DUMP TRUCK), which was also to begin operating on 1 November 1967, small explosive devices (called button bomblets or micro-gravel) would be sown in conjunction with the acoustic sensors; when stepped on, these devices were to explode and generate acoustic signals, which would activate the sensors.

Both acoustic and seismic sensors, when activated, would transmit identity codes by their own self-contained transmitters to EC-121 aircraft, which would orbit the sensor fields to monitor the transmissions. These aircraft would also relay, either automatically or manually by secure voice radio channels, the information from the sensors to DUTCH MILL, the Infiltration Surveillance Center (ISC) at Nakhon Phanom, Thailand.

ISC would analyze this information and correlate it with weather and

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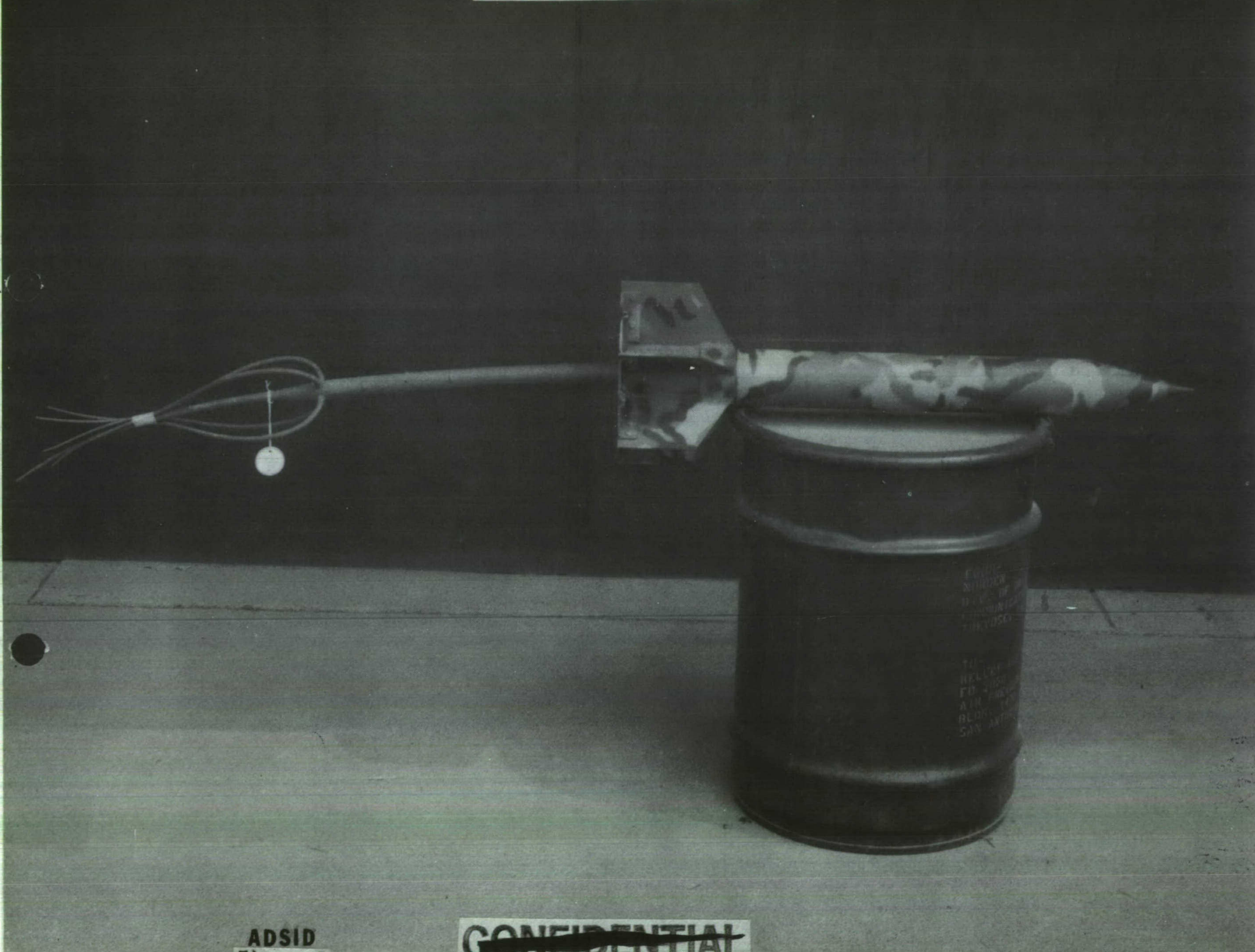

ADSID
Figure 3

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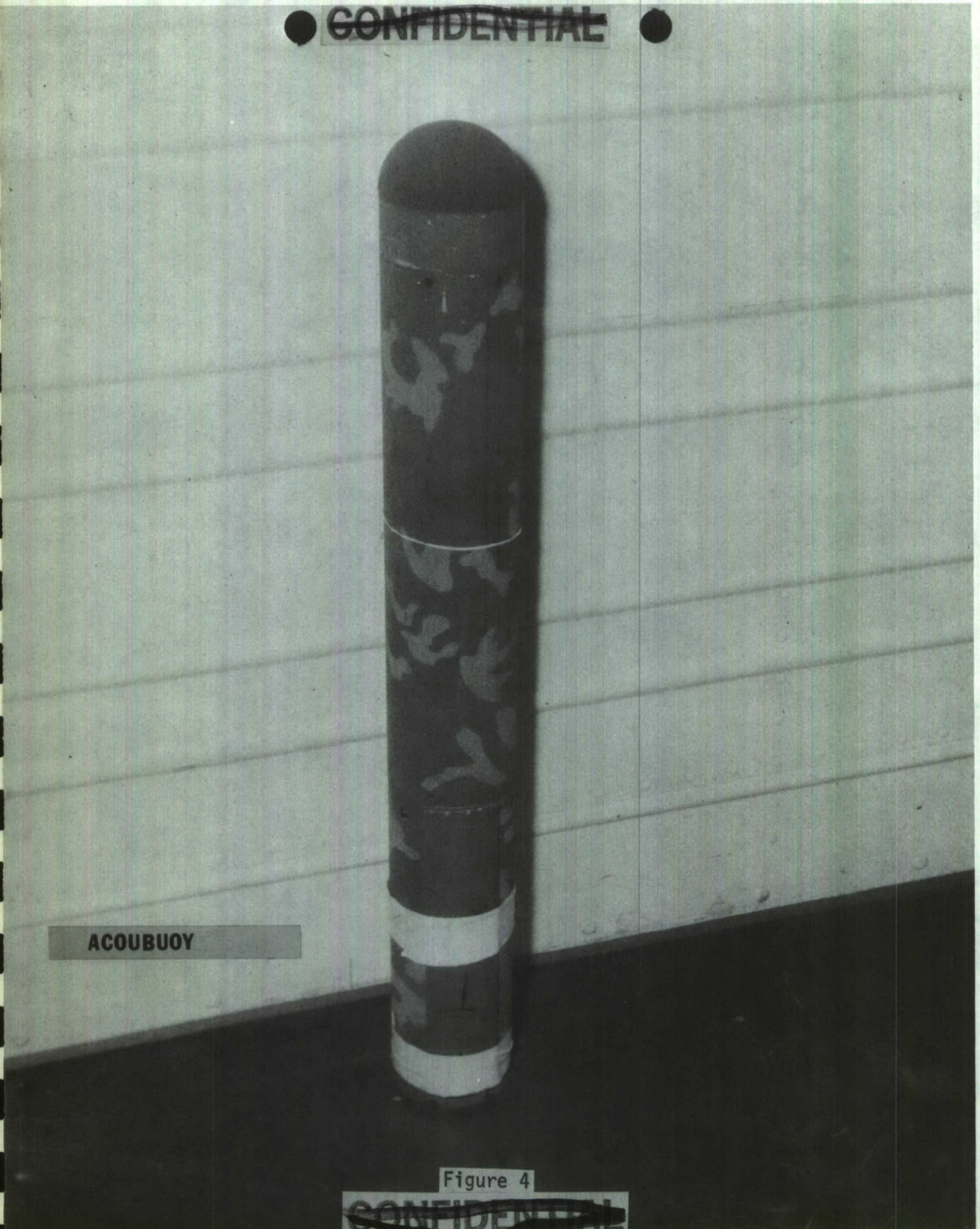

Figure 4

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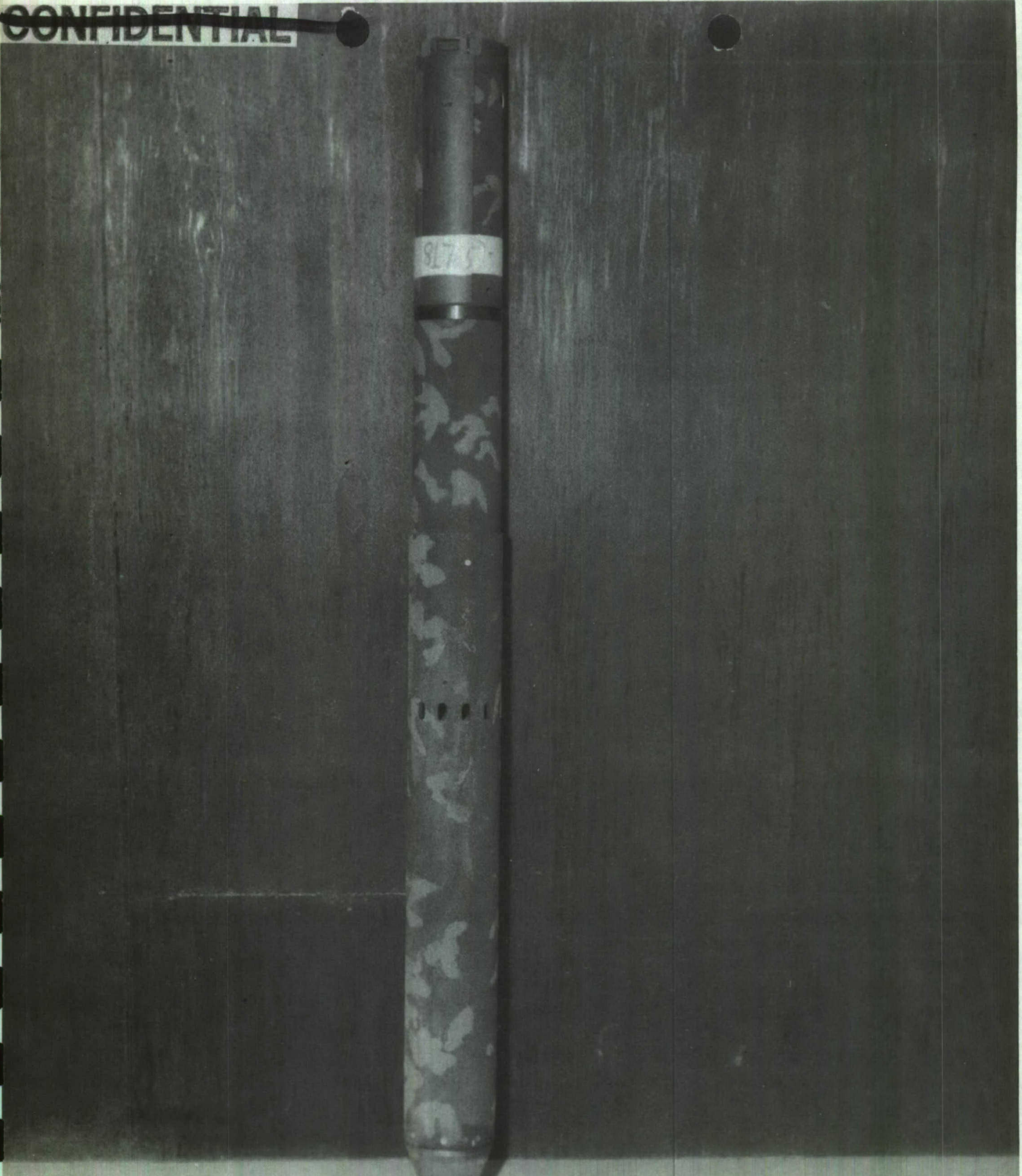

SPIKE ACOUBUOY
Figure 5

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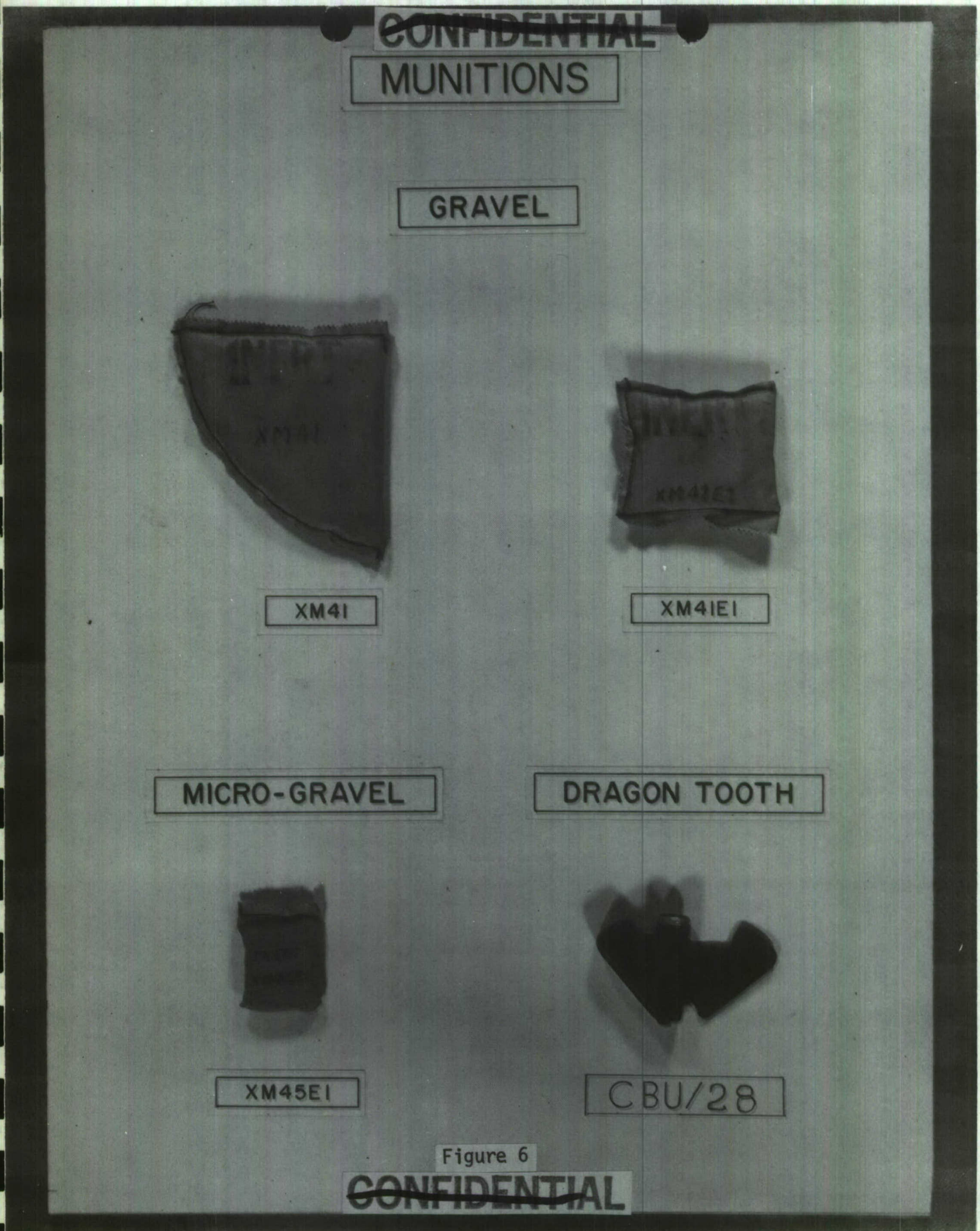

Figure 6

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other intelligence data to determine targets for strike action. Target information including map coordinates, type of target, and rate and direction of movement would then be passed by voice radio to the Airborne Battlefield Command and Control Center for verification by forward air control aircraft and for possible strikes by attack aircraft. 2/ The munitions and sensing devices which were used in the early stages of the MUSCLE SHOALS operation are illustrated in Figures 3 through 6.

Deployment Problems

To support this complex operation, the various components of the system had to be developed, procured, and deployed. Munitions such as gravel mines, micro-gravel, button bomblets, and Dragontooth mines were required in large quantities. Aircraft to deliver both munitions and sensors--the A1-E, the Navy OP-2E, the F-4, and the CH-3 helicopter--had to be modified and deployed. Navigation aids such as the MSQ-77 at Nakhon Phanom had to be provided, and photographic coverage of the MUD RIVER and DUMP TRUCK areas was needed to plan sensor sites, determine sensor drop locations, and provide assessment data for reseeding. The sensing devices themselves--both seismic (ADSIDS) and acoustic (Acoubuoys and Spike Acoubuoys), as well as other types of sensing devices and booby-trapped devices to discourage the enemy's tampering with or removing the sensors--had to be developed, tested, and produced in quantity.

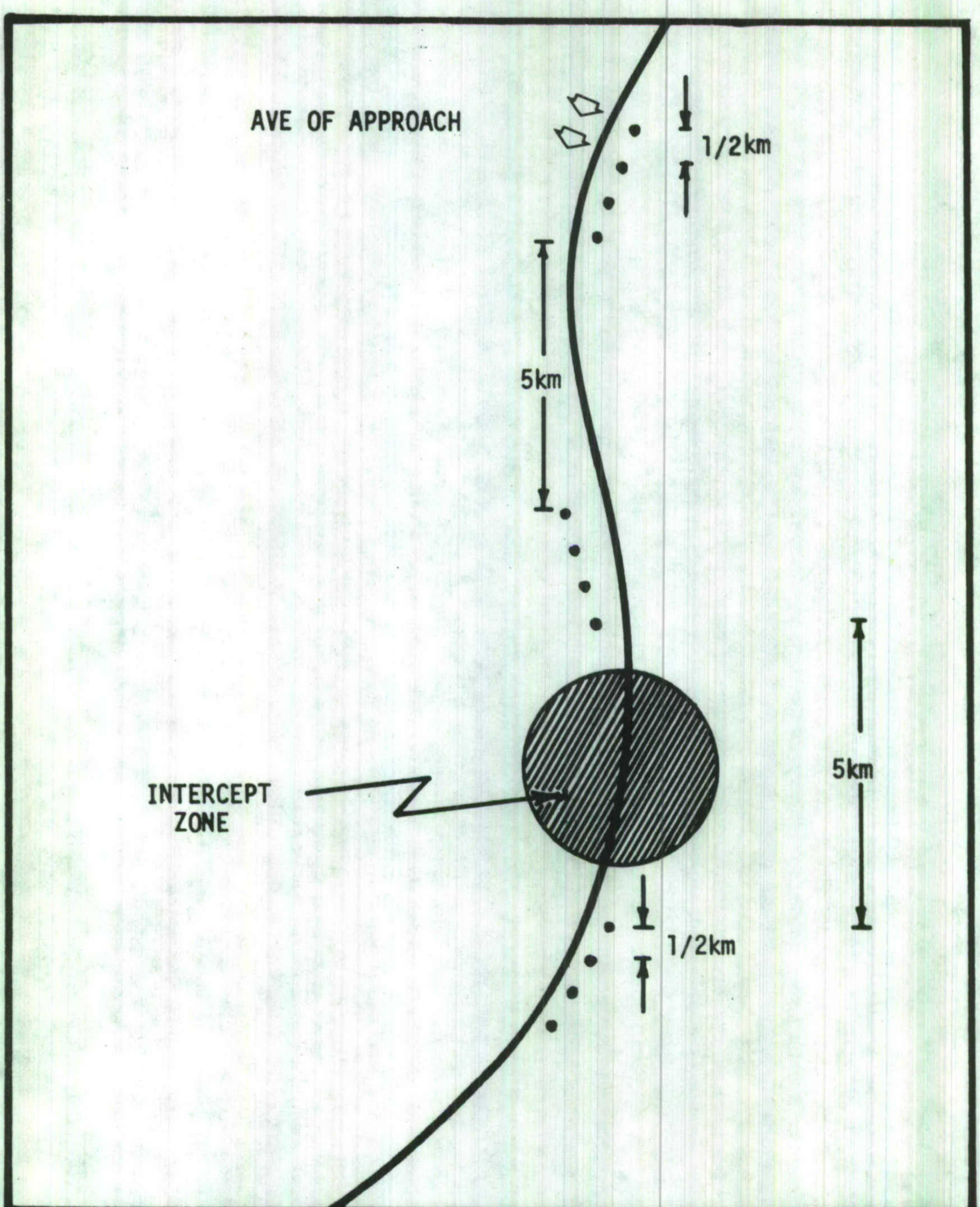
A wing of EC-121 aircraft had to be deployed to Korat RTAFB, Thailand, to provide orbital monitoring for the sensor fields. The Infiltration Surveillance Center with its complex array of communications, computers, data

analysis, and display facilities, photographic equipment, and related support facilities had to be planned and constructed in an isolated portion of the air base at Nakhon Phanom.[3/]

To add further complications, the entire program had to proceed under the strictest possible veil of secrecy, largely because the Thai and Laotian governments were sensitively concerned with the knowledge and control of operations within their national boundaries. This concern meant, for example, that such matters as the transfer of men and materiel into Thailand had to be coordinated in detail with the Thai government and that each area in Laos, where a sensor module (a group of individual sensor strings) was to be seeded, had to be individually coordinated and authorized by the U.S. Ambassador in Vientiane.[4/]

The plans were, by and large, successfully carried out, and on 1 December 1967--an one-month postponement of the originally planned date--the system began operations in the MUD RIVER area of central Laos (Fig. 1). Operations in the DUMP TRUCK area began on 20 January 1968, and were expanded on 21 January to include the area around Khe Sanh in support of the troops under siege in that combat base.[5/]

The actual day-to-day operation of the MUSCLE SHOALS program can best be illustrated by a rather detailed examination of the process of implementing a sensor string, monitoring it, evaluating the data it produced, requesting and achieving verification, and strike of the sensor-developed target, and subsequent reseeding of the string.



BASIC VEHICLE MODULE GEOMETRY

FIGURE 7

Aircraft resources available to support this operation during the period 1 December 1967 to 15 March 1968 were as follows:[6/]

Unit	Nr and Type of A/C	Location (Thailand)
553d Recon Wg	21 EC-121	Korat
1st Air Commando Wg	19 A1-E	Nakhon Phanom
21st Helicopter Sq	12 CH-3E	Nakhon Phanom
23d Tac Air Spt Sq	45 O-2	Nakhon Phanom
Observation Sq 67 (Navy)	12 OP-2E	Nakhon Phanom

(NOTE: The 25th Tactical Fighter Squadron of 18 F-4D aircraft was scheduled to deploy to Ubon, Thailand, in the summer of 1968, to implant the planned sensors, Fighter Aircraft Delivered Seismic Intrusion Detectors [FADSID], which were not in use by the end of March 1968. This list also does not include strike aircraft, which could be dispatched by the ABCCC to attack targets generated by the MUSCLE SHOALS system, nor the Army UH-1 gunships which were to provide escort for the CH-3, but were subsequently withdrawn by MACV.)

Operations described later are typical of those which took place in the Infiltration Surveillance Center at Nakhon Phanom, during the period 22 March through 26 March 1968. The descriptions reflect many of the problems associated with its day-to-day operations during this period. The MUSCLE SHOALS program in its early stages faced problems with technical equipment, command coordination, and effective tactics and procedures were being continually sought.

In general, with the MUD RIVER antivehicular area, modules containing three or more sensor strings (each having four to eight individual sensors) were planned as illustrated in Figure 7, so that the initial string could

identify the potential targets. The next string could confirm their movement along a road or trail, and make possible time-distance information to predict their arrival at an open strike zone when it would be attacked. Then the final string could aid in determining the success of the strike by measuring the number of vehicles moving out of the module after the strike. Similar modules, but somewhat more elaborate, were planned for the DUMP TRUCK antipersonnel area (Fig. 8).

In actual practice, it was often necessary to vary these sensor emplacements because of reconnaissance and delivery problems, terrain characteristics, and other considerations, so that the string itself, rather than the module, became the basic tool of detection and prediction. Figures 9 and 10 illustrate the actual deployment patterns in the MUD RIVER and DUMP TRUCK areas.

Diplomatic Problems

Sensor management personnel in the ISC, after studying intelligence reports on truck routes and photographic coverage of roads and trails in these areas of known or suspected vehicular traffic, would decide on locations and types of sensors which should be implanted. This decision was sent through Seventh Air Force in the form of a request to the U.S. Embassy in Vientiane for authority to seed the sensors and associated munitions.[7] Even though the exact coordinates of a module had been previously agreed upon, each new sensor string implantation request had to be individually validated before operations could begin. The elapsed time between the ISC's request and the reply averaged three to four days, but as of 24 March, one request

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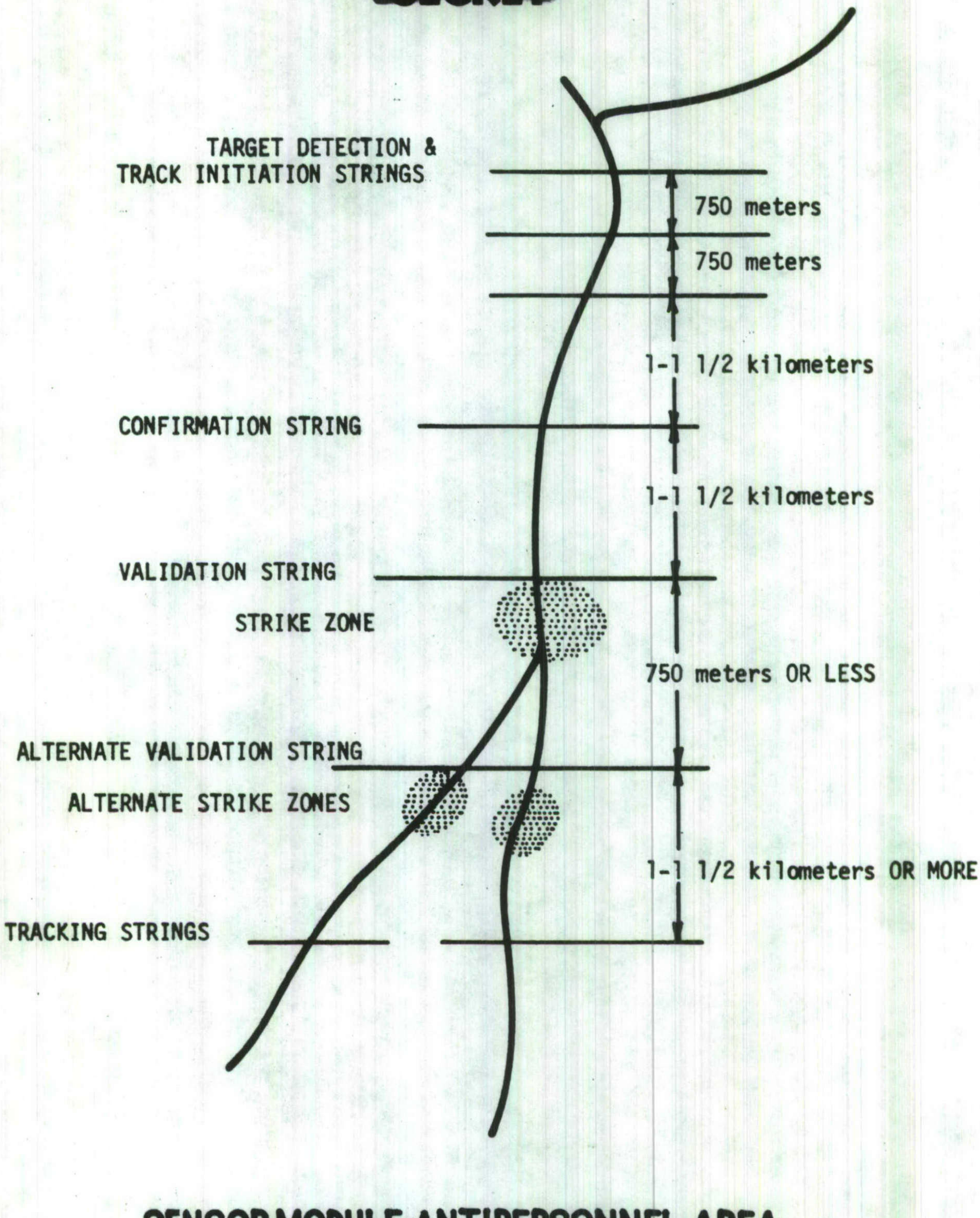

SENSOR MODULE-ANTIPERSONNEL AREA

FIGURE 8

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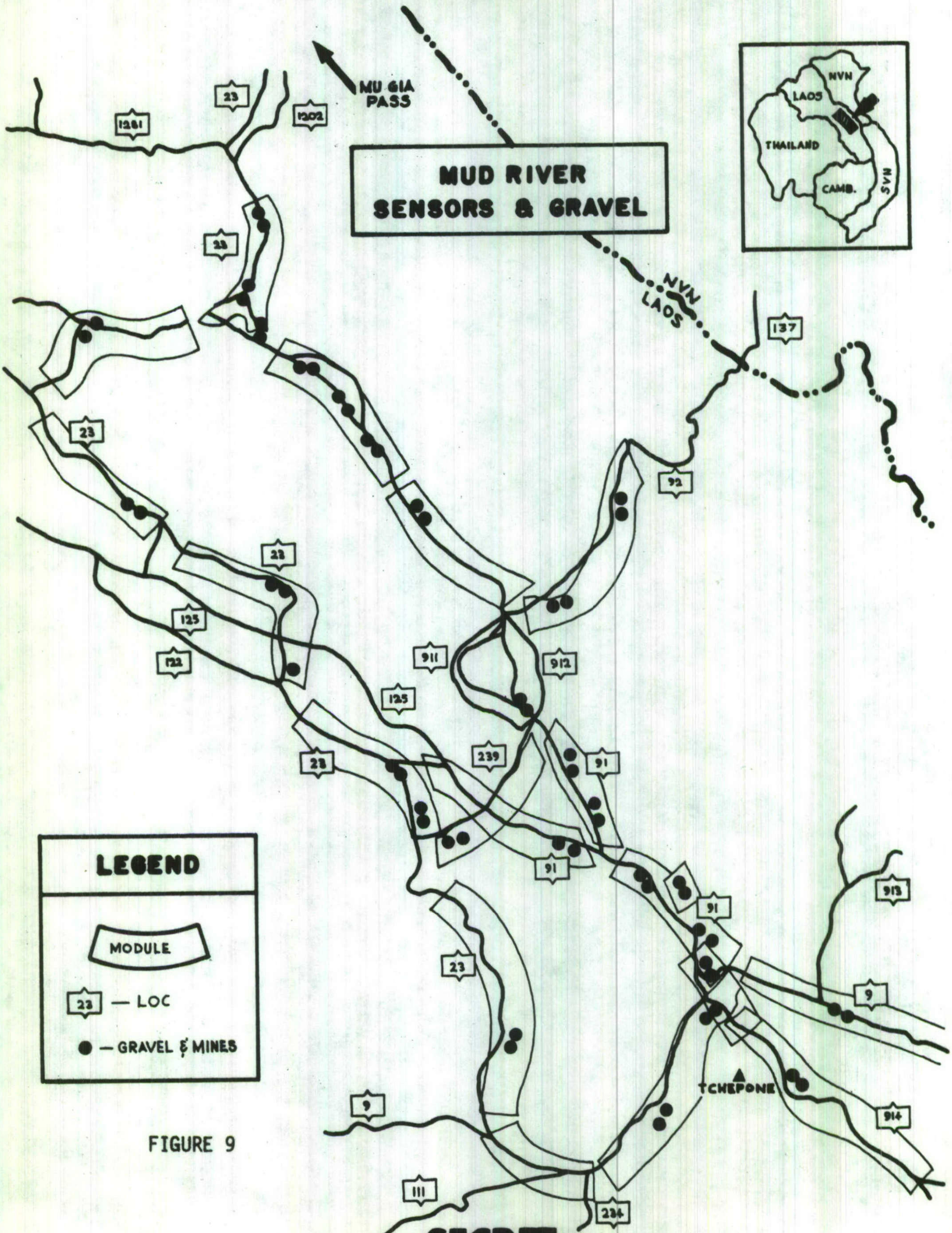

MUD RIVER
SENSORS & GRAVEL
MU GIA
PASS
NVN
LAOS
THAILAND
CAMB.
SVN
LEGEND
MODULE
23 — LOC
— GRAVEL & MINES
TCHEPONE
23
1281
1202
137
92
125
122
911
912
239
91
913
9
914
111
234

FIGURE 9

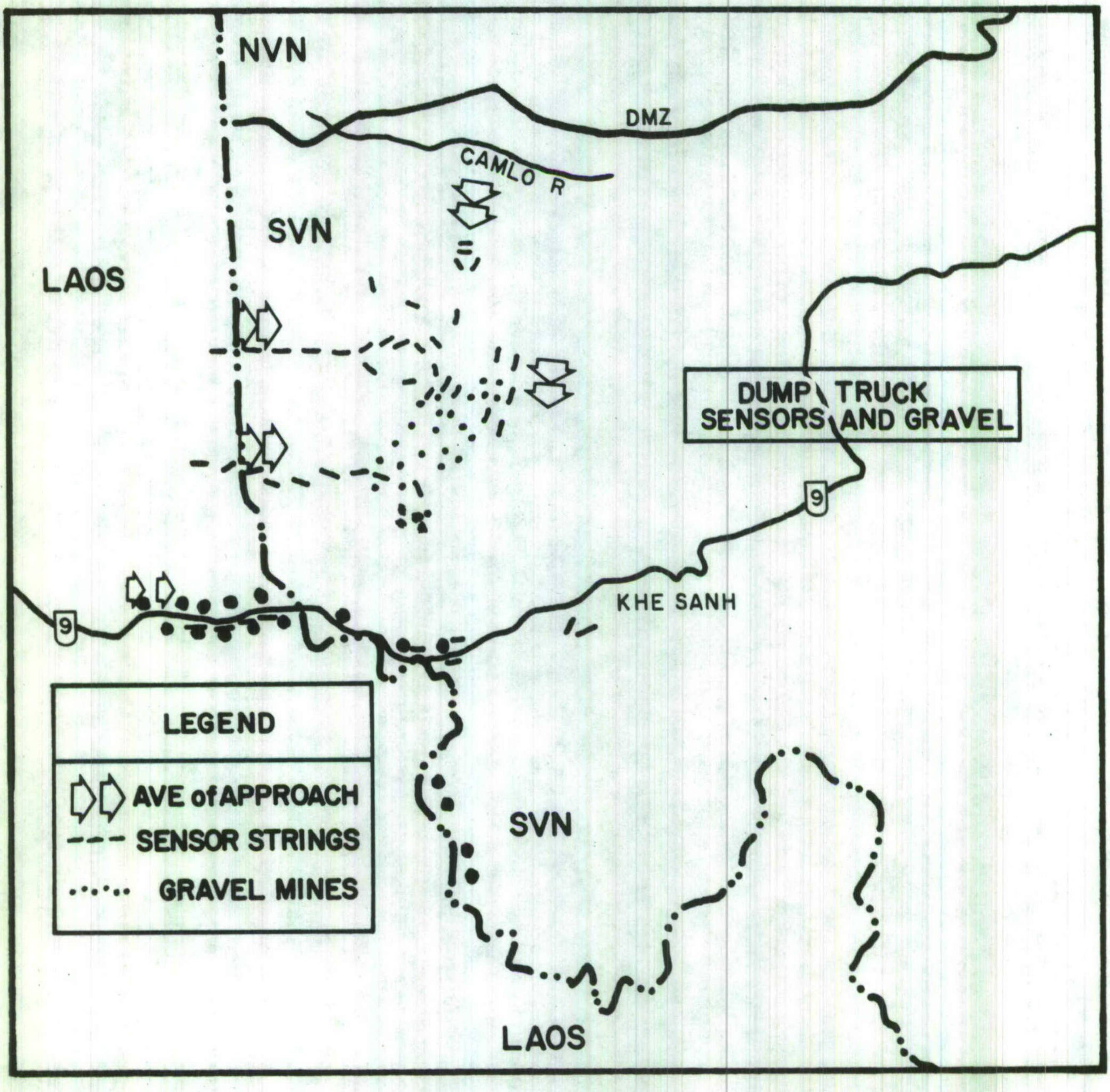

NVN
DMZ
CAMLO R
SVN
LAOS
DUMP TRUCK
SENSORS AND GRAVEL
9
KHE SANH
9
LEGEND
AVE of APPROACH
SENSOR STRINGS
GRAVEL MINES
SVN
LAOS

FIGURE 10

to implant sensors in the extreme western sector of the MUD RIVER area had been pending for more than two weeks.[8/] The lack of authority to reseed sensor strings at new coordinates, even within a previously validated modular area, inhibited the flexibility of sensor emplacement and sometimes delayed adjustments needed to improve sensor string performance and coverage.[9/]

Once authorized to implant sensors in a given location, the sensor managers in ISC, together with operations officers who knew and understood the capabilities of the aircraft and crews which were to implant the sensors, would meet to plan the detailed fragmentary order requests for the missions. These meetings were held in sufficient time to forward "frag" order requests to the 7AF Tactical Air Control Center at Tan Son Nhut, 48 hours in advance of the desired mission date. A copy of these requests would also be sent to the mission units involved, so they could have advance notice and preparation time, and could also request any changes they thought necessary. Seventh Air Force would integrate these requests from Task Force Alpha into the overall interdiction effort.[10/]

When TACC had approved the mission request and issued the orders, the normal procedures of briefing forward air controllers and aircrews, preparing the aircraft for the mission, and executing the sensor plant or munitions drop would follow.

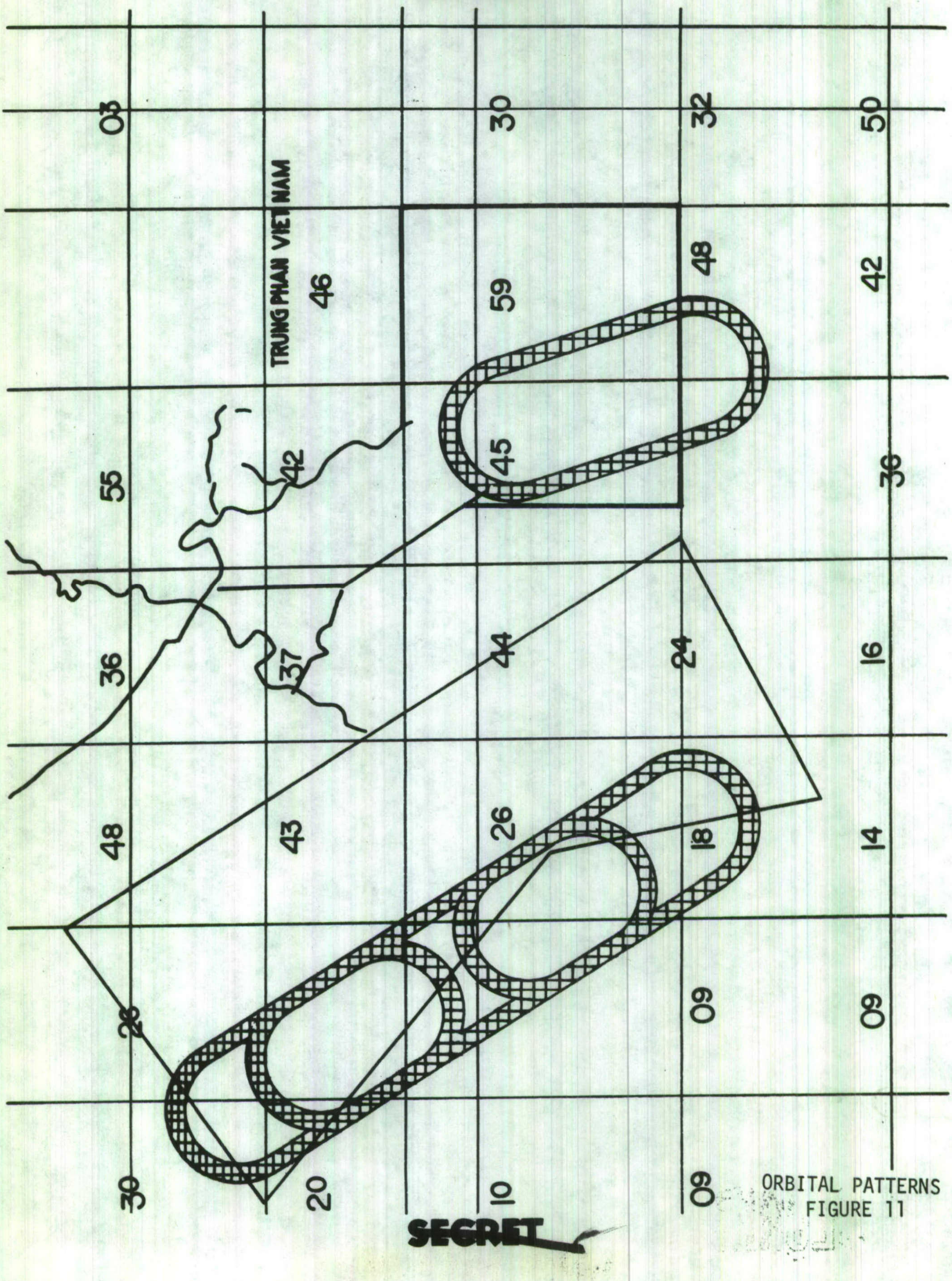
Aircraft Resources

A typical mission for one of the Navy OP-2E crews was briefed at 0800 hours on 24 March, in the Tactical Unit Operations Center (TUOC), at

Nakhon Phanom, for a sensor emplacement drop in the eastern MUD RIVER area. Because of the vulnerability of these modified Lockheed Neptune aircraft to ground fire, and because three of the original twelve aircraft assigned to the squadron had been lost in combat, they were at this date restricted to flying only in the relatively safe areas along the western sector of the MUD RIVER area. The crews were instructed by the briefing officer to make one pass only over the target.[11]

At 1200 hours on the same date, the pilots of six A-1E aircraft were briefed at the Nakhon Phanom TUOC. Four aircraft were to drop XM-42 gravel mines in two areas along Route 92 in central Laos, and two were to escort them armed with CBU antipersonnel bombs. After receiving a complete briefing on the target, weather, and current intelligence data, these crews gathered with their forward air controllers to discuss and agree upon the exact tactics and procedures to be employed on the missions. These were the usual procedures for implanting munitions and sensors; however, other aircraft were often used for implanting sensors. The CH-3 helicopter proved to be the most effective of all the aircraft used in the DUMP TRUCK antipersonnel area around Khe Sanh during February and March 1968, but these aircraft could operate without undue risk only in areas of light enemy ground fire. The helicopters were seeding both the ADSID and Acoubuoy sensors by hand-drop from the side door of the aircraft.[12]

Because of the previously cited vulnerability of the OP-2E, six F-4 aircraft from the 8th TFW had been modified with special intervalometers to permit them to emplace ADSIDs. On 24 February 1968, the first F-4 ADSID



ORBITAL PATTERNS
FIGURE 11

emplacement was successfully accomplished in MUD RIVER. Continuing the shift from the slower and more vulnerable aircraft to the F-4, the CBU-28 Dragontooth mine was initially employed in MUD RIVER on 5 March 1968. These arrangments were designed to provide an interim high speed sensor emplacement capability until arrival in-theater of the 25th TFS. (This squadron of F-4s, which had been originally programmed for deployment to Ubon, Thailand, for an 1 March 1968 Initial Operational Capability [IOC] had been rescheduled for deployment in late May 1968 to meet an 1 June 1968 IOC.)[13/]

Once a sensor string was implanted, the next crucial task was to determine accurately where each individual sensor was located on the ground or in the case of parachute Acoubouys, in the foliage. Photographs were taken by implanting aircraft at the time each sensor was released. These photographs had to be correlated at the infiltration surveillance center with specific map coordinates, so the precise position of each sensor could be plotted.[14/] Accuracy in delivering and in plotting the site of delivery was crucial in assessing the information produced by a sensor string. General McBride cited accurate sensor delivery as the most pressing single problem facing the entire DUTCH MILL operation.[15/]

<u>EC-121 Operations</u>

Data from implanted sensors were automatically relayed, in a code pattern unique to each sensor, to the EC-121 aircraft which maintained continual orbits over the sensor fields. These aircraft based at Korat, normally flew in orbit for eight hours, or until relieved by a replacement aircraft. The orbital patterns were similar to those outlined in Figure 11,

but because of the extension of the DUMP TRUCK area to include Khe Sanh, the orbits over that area were moved eastward to allow better reception of those sensor signals which were used to help identify potential targets for airstrikes and Marine artillery in the area around that besieged combat base. Reports reaching the ISC at Nakhon Phanom indicated the Marines were well-pleased with information received from sensor analysis, and that they directed artillery fire on these suspected targets whenever their ammunition supply permitted.[16/]

The orbit of the EC-121 Bat Cat aircraft on the night of 26 March, was typical of these missions. The aircraft flew an orbit within an area about ten miles square, just west of Khe Sanh. The first four hours of the eight-hour orbit were flown at 18,000 feet, the last four at 20,000 feet. The crew of 20 men included specialists in electronic countermeasures, because this orbit approached the maximum range capability of the previously observed Surface-to-Air Missile (SAM) site near the Demilitarized Zone. Other specialists monitored the equipment which received signals from the sensors and retransmitted the signals automatically to the ISC at Nakhon Phanom.[17/] Simultaneously, two other orbits were being flown over the MUD RIVER area to the northeast.

Most of the relay operation was automatic, but the monitors could have transmitted data orally by secure voice circuits, should there have been any malfunction in the automatic relay equipment, or should there have been any other operational requirement to do so. Actually, it was possible to hear the sounds from the battlefield area below which were transmitted by

the Acoubuoys. Each time an Acoubuoy was activated it would remain alive for eleven seconds, during which foreign voices, overflying aircraft (occasionally the EC-121 itself), automatic weapons fire, and bomb, or artillery bursts could be heard. Additionally, coded activations of the seismic detectors were frequent. No EC-121 aircraft had been lost or damaged because of hostile fire through March 1968, although occasional 37-mm antiaircraft fire could be seen in the area around the aircraft on the mission of 26 March. The effective range of this antiaircraft fire was considerably less than the orbiting altitude of the aircraft.[18/]

Maj. Travis T. McAfee and his crew in aircraft Number 8 had a sense of unity and an esprit de corps, which were remarkable in view of the comparatively monotonous flight and monitor duties they performed. Several monitors expressed the desire for more feedback information on what eventually happened to the sensor data they relayed. One also said he had learned that the Marines needed and were benefitting from the target data generated in the DUMP TRUCK area near Khe Sanh. He expressed satisfaction that the work they were doing was contributing to the defense of Khe Sanh.[19/]

Target Assessment

Data generated by the sensors and retransmitted to the Infiltration Surveillance Center by the EC-121 aircraft were normally fed automatically into a computer, which furnished continually updated printouts at the rate of one sheet every five minutes, for each of four target assessment officers. Each of them worked at a table in a large plotting room containing a transparent plotting board on which were displayed the locations, designations,

and targets generated by each sensor string in each module.

Two of these tables were used for monitoring the MUD RIVER area, two for the DUMP TRUCK area. For 24 hours every day, these tables were manned by target assessment officers, who served eight-hour shifts. The majority of these were lieutenants who had been trained at the testing and training facility at Eglin AFB, Florida. Every five minutes during that eight-hour period, a new computer printout was dropped onto each of their tables by an airman messenger whose duty it was to distribute these printouts as they came in. Each printout covered a total period of 50 minutes, and showed the duration of every sensor activation in percentages of each one-minute period during which the sensor was active.

The apparently random nature of the sensor activations (indicated by the presence of numbers in columns under each sensor identification number), provided a difficult and complex task for the target assessment officer to distinguish with confidence those numbers which formed enough of a pattern to indicate the probability of truck or personnel traffic along a route covered by the sensor string. Many of the columns without any recorded activations could represent either sensors that had gone dead, had been poorly emplaced, or were simply not activated during the period covered by the printout. Many of the activations were caused by random activity such as exploding ordnance, gunfire, animals, thunderstorm activity, or simply by the hyperactivity of the sensor itself. Orientation of each of the strings along a route also had to be known as well as accurate plotting of locations and distance between each of the sensors, to allow the assessment

officer to identify and calculate with any accuracy the movement of trucks or personnel through the string.

Essentially, the procedure followed in identifying and reporting possible targets was accomplished by knowing the distance between two sensors and the time elapsed between the initial activations of each. For example, the assessment officer would calculate a movement northward (which he determined from a map showing the directional orientation of the sensor string along a route), at 17 kilometers per hour. By noting how long each of the sensors was activated, he could estimate the number of vehicles in the group moving through a string. This gave him enough confidence to identify this activation pattern as a potential target, and he estimated that target to be five trucks moving northward at 17 kilometers per hour. He then transmitted this target sequence to the ISC operations room for recording and relay to the ABCCC for possible visual investigation by a FAC and possible strike action, if confirmed.

During periods of heavy sensor activity, the target assessment officer had great difficulty in distinguishing targets by identifying characteristic movement patterns, as they developed within the maze of apparently random activations. Notable, too, was the difference in interpretive criteria needed to distinguish patterns in the antipersonnel area versus those applicable in the antivehicular area. It was desirable that each target assessment officer get to know intimately such things as the peculiar characteristics of the terrain, the weather, the road and trail network, the kinds of potential spurious activations, and the individual sensor performance of each of the

strings and modules in his area of responsibility.

Every target assessment officer interviewed stated his need for more feedback from visual reconnaissance to confirm his suspected target calls. Often given numerous activations, the need existed for rapid judgments on suspected target sequences as they developed, and the individual peculiarities of each sensor and sensor string. It was a matter of great concern to these officers in the detection and identification process, to develop through such feedback verifications, the confidence that their calls and predictions were valid.

As will be seen later in this report, in MUSCLE SHOALS operations through March 1968, the percentage of targets generated and reported to the Airborne Battlefield Command and Control Center aircraft, which were actually looked at by a forward air controller, was not large. Once a target had been identified and recommended to the ABCCC for visual verification and possible strike action, MUSCLE SHOALS control as exercised by 7AF Task Force Alpha ceased; further action was at the discretion of the 7AF Tactical Air Control System, and in context with overall 7AF interdiction operations.

<u>Reseeding Problems</u>

In developing and maintaining the ability to predict accurately the movement of sensor-generated targets along the maze of roads and trails covered by the sensor fields, the target assessment officer needed to know precisely where on the ground or in the foliage near a road or trail each sensor was located. Not only his ability to predict, but the very usefulness of the sensor itself, depended on its being accurately emplaced at a known

location within the range of its sensitivity and within an accurately deployed string.[20] Because each sensor transmitted a unique signal and because the number of available channels and codes was finite (a total of only 837 discrete signatures with the equipment in use through March 1968), any inaccurately emplaced, malfunctioning, or completely dead sensor within a string, often seriously inhibited the effectiveness of the entire string as a detection and prediction device. Because the pre-set expiration times and the battery-life predictions on the seismic and acoustic devices used during this period did not prove to be reliable, even the reseeding of a sensor string was often delayed until the last sensor in the string had gone dead and the entire string could be replaced at once.

To indicate the magnitude of the reseeding problem, these figures show the number of sensors dropped versus those remaining active at the end of the period shown for each month of operation in the MUD RIVER area to 23 March 1968:[21]

Date	Dropped	Type	Active at end of period	
	247	ADSID (seismic)	158	
Dec 1967	42	Acoubuoy (acoustic)	10	
Totals:	289		168	(49 strings 17 modules)
	94	ADSID	116	
Jan 1968	98	Acoubuoy	34	
Totals:	192		150	(42 strings 17 modules)
	134	ADSID	120	
Feb 1968	80	Acoubuoy	24	
Totals:	214		144	(37 strings 18 modules)

Date	Dropped	Type	Active at end of period	
	112	ADSID	161	
Mar 1968	78	Acoubuoy	16	
Totals:	190		177	(37 strings 17 modules)
(to 0700 local, Nakhon Phanom time, 23 March)				

Summarizing these statistics: From December 1967 to 23 March 1968, a total of 588 seismic (ADSID) sensors and 298 acoustic (Acoubuoy) sensors had been dropped into the road and trail complex in the MUD RIVER area of central Laos--a grand total of 886. Of these 886 sensors, 161 seismic and 16 Acoubuoys were still active as of 0700 hours on 23 March 1968. These active sensors were on that date deployed as 37 sensor strings within 17 modules.

Similar "dropped versus active" figures for the DUMP TRUCK area were as follows: 22/

Date 1968	Dropped	Type	Active at end of period	
	171	ADSID (seismic)	104	
Jan	145	Acoubuoy (acoustic)	106	
Totals:	316		210	(44 strings 9 modules)
	25	ADSID	103	
Feb	74	Acoubuoy	67	
Totals:	99		170	(46 strings 13 modules)
	119	ADSID	94	
Mar	97	Acoubuoy	88	
Totals: (to 0700 23 March)	216		182	(33 strings 9 modules)

Summarizing these figures: From 1 January to 23 March 1968, a total of 315 seismic (ADSID) sensors and 216 acoustic (Acoubuoy) sensors had been dropped into the DUMP TRUCK area (including its extension into the Khe Sanh area, which was approved on 19 January and initiated on 21 January 1968)--a grand total of 531. Of these 531 sensors, 94 seismic and 88 acoustic were still active as of 0700 hours on 23 March 1968. These active sensors were deployed as 33 sensor strings within 9 modules.

A continual reseeding program, both for sensors and related munitions (explosive devices needed to activate Acoubuoys in the antipersonnel area and mines to damage vehicles and impede the movement of personnel in the antivehicular area), was necessary to keep the MUSCLE SHOALS program in operation. Much of this reseeding effort, however, had been planned for and expected; it was a part of the designed nature of the sensors that their useful life in the field would be short and the munitions would be self-sterilizing.

Hardware

None of the sensor devices used through March 1968 performed up to design specifications: The seismic (ADSID) sensors made by Sandia Corporation were by far the most reliable--General McBride referred to them as "the backbone of the system"--but even they had an unreliable end-of-life timer, and often penetrated too far into soft soil for proper operation of the sensing and transmitting equipment. 23/ The Acoubuoy acoustic sensors were degraded by many which had poor audio quality, unreliable end-of-life timers, and short lives because of hyperactivity. The average life of the

Acoubuoys proved to be six to seven days rather than the expected ten days. One notable exception was an Acoubuoy which missed its expiration date and amazed the sensor management team by continuing to operate for 55 days, thus usurping one of the finite number of frequency codes for the whole period.[24/]

The seismic sensors designed to be delivered by dispenser tubes from helicopters (HELOSIDS) did not meet design specifications. Reliable sensor operation was not possible because of improper implant angle and because of damage sustained on impact. The HELOSID had never been used in actual operations as of March 1968. The hand emplaced seismic sensor (HANDSID) developed problems with its logic circuitry.

The sensor was designed for use in a quiet jungle area; however, its use was attempted in the seismically noisy environment of Khe Sanh. Under these conditions, the automatic gain control overreacted when a group of trucks or personnel passed the sensor, so that it effectively became deaf to the sustained movement. Then HANDSID, also, had not been operationally used by March 1968.[25/]

Summary of Sorties

The introduction into a combat situation of much equipment not completely tested and proved effective was undoubtedly a hindrance to the efficiency of MUSCLE SHOALS.[34/] Despite these and many other technical problems, the planned sensor fields were kept active. A summary of sorties flown in each of the two MUSCLE SHOALS areas during January and February 1968 follows:[26/]

MUD RIVER AREA

	1-31 Jan	1-29 Feb
Sorties flown:	425	473
Sensor emplacement:		
OP-2E	30	35
F-4		1
Munitions Seeding:		
A-1E	40	110
Escort sorties:		
Jet Acft	34	46
Prop-driven Acft	44	38
FAC sorties:		
O-2	89	69
EC-121 orbit sorties	188	174

DUMP TRUCK AREA
To 29 Feb

	To 29 Feb
Sorties flown:	344
Sensor emplacement:	
OP-2E	13
CH-3 (airdrop)	10
Munitions seeding	
A-1E	103
Escort sorties	
Prop-driven acft	32
FAC sorties	
O-2	99
EC-121 orbit sorties	87

These figures total 898 sorties in the MUD RIVER area and 344 sorties in the DUMP TRUCK area, a total of 1,242 sorties flown in January and February 1968, in support of MUSCLE SHOALS operations in Southeast Asia. These figures show only the commitment of air resources used directly to support the emplacement and monitoring of sensors and munitions; they do not include missions to verify or strike targets generated by the system.

Summary of Problems

During these early months of operation and test, major problems affecting the performance of MUSCLE SHOALS day-to-day process of data collection and analysis were of crucial concern, so that strike forces could be brought to bear on targets generated. Of vital interest, also, were problems arising in the Infiltration Surveillance Center.

Chief among these was accuracy of sensor emplacement. It has already been shown how important it was that the sensors be delivered with precision and that their positions be recorded with certainty; the delivery problem, however, remained a crucial one at the end of March. The OP-2E had proved both vulnerable in combat and marginal in accuracy of sensor emplacement. From 1 December 1967 through 15 March 1968, a total of 160 drops were made in the MUD RIVER area of central Laos. OP-2E missions produced errors in range (averaged for two week increments during the period covered) from 262 meters to 715 meters, and errors in deflection from 143 meters to 248 meters. Similar figures for the period 17 January-15 March 1968, for 34 drops by the OP-2E in the DUMP TRUCK area produced errors (averaged by weekly increments during the period covered), varying from 212 meters to 370 meters in range and from 5 meters to 200 meters in deflection. These errors illustrate the prevalent irregularities in sensor string patterning and the difficulty of achieving a planned and desired sensor field in a given area or along a given route.[27/]

Although the CH-3 helicopter, using a makeshift hand-dropping technique, achieved better accuracy, its vulnerability prohibited it from operating in

heavily defended areas. The F-4s, which had been modified to fly sensor emplacement sorties in the high threat areas, had by the end of February flown only one such sortie. General McBride expressed concern that the delivery accuracy of these high speed aircraft, which were planned as the chief delivery vehicles at a later stage of MUSCLE SHOALS operations, would not prove adequate to solve the sensor-accuracy problem. 28/

Another major problem was the failure of the sensors to perform according to specification. By 31 March 68, not a single one of these devices had functioned satisfactorily in the field under combat conditions, although the ADSID (Fig. 3) had, as already noted, established itself as the most reliable and therefore the most useful of the sensing devices used to that date. 29/

A third problem involved losses in the data loop, some within components aboard the EC-121 aircraft and some within the infiltration surveillance center itself. Interference with the VHF antennae and drift in the ARR-52 receiver were among problems with equipment aboard the EC-121. Within the ISC, computer and teleprint equipment was sometimes overloaded by unexpectedly large data input from the sensors, much of it caused by random activations of the sensors by activating agents other than potential targets. 30/

Among the restrictions, it was necessary to request and await authorization from Vientiane for altering the location of sensor strings within Laos, even though it often became obvious that such relocations could improve detection probabilities in areas of established traffic and could provide

a road watch capability in areas in which new traffic might appear. In short, the requirement to revalidate often tended to restrict the tactical flexibility of the sensing system and to prevent rapid adjustments which might have proved productive. [31/]

The relatively low percentage of confirmations for a target assessment officer during a typical eight-hour period of duty at the assessment table in the plotting room resulted in two adverse effects: (1) it reduced the willingness of the assessment officer to declare targets, especially at times and in areas producing a large number of activations, many of which were known or strongly suspected to be caused by random forces other than probable enemy activity; and (2) it reduced his confidence in those sequences which he did declare and report, only to receive no confirmation either of the success or failure of his judgment.

One remaining problem prevailed constantly during these early months of operation of a system in which so much time, money, and technical resources were invested. Because of the high priority assigned to the MUSCLE SHOALS program to meet the initial operational capability dates established by the Secretary of Defense, the time was often spent in a pressure-packed rush to get the entire program in high gear. This time, under less urgent conditions, would have been used to design and test equipment, assemble and train personnel, construct and equip new facilities, moving with a more deliberate speed toward the final employment of this complex mechanism in combat. Once the MUSCLE SHOALS program was set up and operating, however, too much was expected of the system, with insufficient time to define its true capabilities

and to analyze and assess rationally and unhurriedly its progress in realizing them.

The ISC DUTCH MILL facility at Nakhon Phanom, for example, received high-ranking military and civilian visitors, who were very interested in its operations. Between Saturday, 23 March and Monday, 25 March, General McBride and his staff consumed much time presenting three full-scale briefings, with tours conducted for high-ranking officers and civilians. Many other less elaborate interviews with interested and inquiring visitors were also held. 32/

CHAPTER III

MUSCLE SHOALS ACCOMPLISHMENTS THROUGH 31 MARCH 1968

Coordinated efforts at Seventh Air Force Headquarters, MACV, PACAF, and the very highest levels of command within the Department of Defense, had been programmed to collect and evaluate reliable data, which would indicate the contribution of MUSCLE SHOALS to the overall interdiction effort in Laos.

Several factors contributed to the difficulty in pinpointing actual achievements of the MUSCLE SHOALS program from 1 December 1967, when the MUD RIVER (antivehicular operation) began, to 31 March 1968. First, during the dry season in central Laos, which prevailed generally from November 1967 through March 1968, the enemy greatly increased their efforts to move men and supplies southward along the roads and trails in the MUD RIVER area.

Target Verification

Accordingly, air was often saturated with targets to strike, which had been acquired by already existent visual and mechanical means, other than the sensor fields. The forward air controllers and strike aircraft operating in the MUD RIVER area, which was only a portion of the previously established STEEL TIGER (SL) interdiction area in Laos, were fully occupied much of the time in conducting strikes on lucrative targets, whose nature and location (Fig. 12) were already known.

In this environment, those who controlled FAC and strike forces--Seventh Air Force TACC and the ABCCC--were reluctant to divert their limited resources

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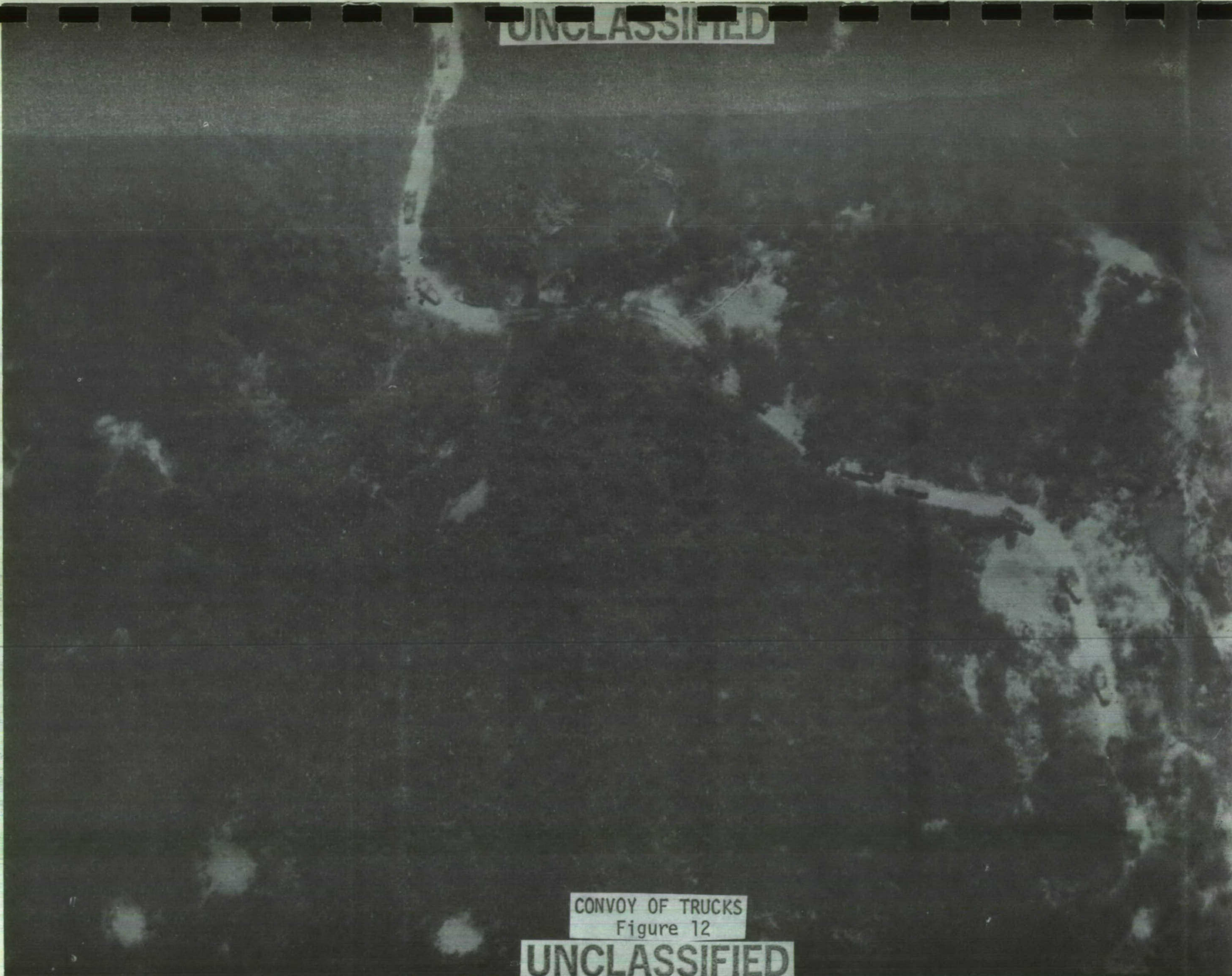

CONVOY OF TRUCKS
Figure 12

UNCLASSIFIED

to investigate sensor-generated targets, when forward air controllers had acquired and were requesting strike aircraft to attack targets in plentiful quantity. In other words, there was often during these months a shortage of available strike and FAC aircraft equipped with truck-killing ordnance in the MUD RIVER area, as well as in the entire STEEL TIGER zone, which included and surrounded this area.[1]

Even when a FAC was dispatched by the ABCCC to seek verification of a reported sensor-generated target, he would often, while en route to the proper coordinates, acquire visually a truck convoy, which to him was understandably more lucrative than the possible target he had been sent to look for. When thunderstorms and showers were prevalent in the area--and these occurred, especially at night, despite the so-called "dry" season--it was often impossible for FAC aircraft to locate targets at all. For example, of the more than 1,200 vehicular target sequences (known as Spotlight Reports) forwarded by the Infiltration Surveillance Center to the ABCCC during January 1968, in the MUD RIVER area, a total of 1,114 were not verified. Reports revealed the following:[2]

Reasons	Nr Sequences
No visual contact	374
Weather over target	155
No FAC available	138
Strikes already in progress	328
Other operations in the area	104
No strike forces available	8
Aircraft diverted to more lucrative target	7
TOTAL	1,114

Of the remaining, 79 were actually investigated and confirmed by FAC aircraft, according to figures furnished by ISC (7AF data shows a total of 83 confirmed). In either case, the confirmation rate was only slightly more than six percent of the sequences reported.

In his briefing in the ISC at Nakhon Phanom for Lt. Gen. Albert T. Clark and his party on 24 March 1968, General McBride cited the statistics indicated in Appendix I to illustrate the situation from 1 December 1967 through 24 March 1968.[3/]

Thus, according to these figures, out of a total of 3,964 target sequences furnished as Spotlight Reports by Task Force Alpha to the ABCCC during the period, 446 were confirmed as targets and of these 370 were actually struck. The remaining 3,518 sequences were not verified, often for reasons which have been illustrated in the examination of specific sequence reports. These figures--as updated, amended, and analyzed at Seventh Air Force Headquarters--show monthly results in percentage of target confirmations, and actual damage assessments from resulting airstrikes, as indicated in Appendix II. The relatively high rate of confirmations achieved in February (27.6 percent) fell off again to a rate of 5.2 percent as of 24 March, largely because of bad weather in the MUD RIVER area, especially at night when truck traffic along the roads and trails was at its peak.

<u>Contribution to Vehicular Interdiction</u>

An analysis of 1 March 1968, of these and other data by the Seventh Air Force Directorate of Tactical Analysis, was compared with data for December

1966, taking into account the estimated increase in enemy truck activity in the Laotian Panhandle area. The increases in effectiveness of the interdiction efforts in December 1967 were as follows:[4/]

	Factor Increase
For trucks destroyed	3.8
For trucks damaged	1.3
For secondary explosions	3.1
For secondary fires	3.2

A MUSCLE SHOALS analysis prepared by the Special Combat Analysis Division at Seventh Air Force Headquarters stated:[5/]

> *"This improvement in interdiction capability can be partially attributed to the MUSCLE SHOALS system. However, credit must also be given to improved tactics, extensive use of the Starlight scope, the introduction of more O-2 FAC's in the area, the use of the C-130 as a strike aircraft, and finally the enemy himself, who in his quest to overrun and recapture certain base areas in South Vietnam, has inserted more trucks into the logistical pipeline to speed up his resupply effort. As a result we have more targets to strike than we've ever had before in the Laotian Panhandle."*

This analysis appears to have underscored a basic problem in assessing the MUSCLE SHOALS system as it affected the truck interdiction effort in Laos through March 1968. In the place, at the time, and under the conditions of its employment as a truck detecting and target generating device, the system was almost redundant to the target acquisition capability already functioning in the MUD RIVER area. The conclusion must not be made, however, that the system itself did not operate effectively, nor that it would not have operated as an important detection and intelligence gathering system under less target-saturated conditions. In absolute terms, 8.7 times as

many trucks were destroyed in December 1967, as those in December 1966. Furthermore, the anti-infiltration system surpassed the three-fold increase in damage to enemy resources established as a goal by the Secretary of Defense.

It would be a mistake to judge the effectiveness of MUSCLE SHOALS simply by attempting to count the truck kills which could be attributed directly to sensor detections. In the first place, even counting such kills was seriously complicated by the circumstance that often a forward air controller would sight a target simultaneously with a sensor detection of the same target. Because of such circumstances as this, it was most difficult to assess accurately the contribution MUSCLE SHOALS actually did make to the truck destruction effort during those early months of its operation. Judged purely in terms of its assured direct contribution to this effort, MUSCLE SHOALS appeared relatively insignificant. But in other ways, the system was by the end of March 1968, beginning to reveal new potentials not fully comprehended within the specific operational missions which had been emphasized before its actual deployment and baptism-under-fire in the field.

Many improvements in the tactical uses of the system were also developed and put into operation by 31 March. Reseeded sensor strings often performed much better than the original strings because of minor relocations to improve track generation. Correlations of FAC visual sightings with the data cards kept by target assessment officers often made possible more accurate sequence fingerprints for a given sensor string. Other correlations of the number of tracks generated with the number of active sensors in a string

also made it appear that three or four active sensors were the optimum number in a truck detecting string.[6/] The summation of such apparently minor improvements in deploying MUSCLE SHOALS resources was beginning by the end of March to make possible a more refined and confident assessment of its potential as a reliable source of target intelligence.

One of the capabilities not possible to assess fully at the end of March was the contribution the DUMP TRUCK sensor and mine deployment had made to the defense of the besieged Marine base at Khe Sanh, in the area just south of the Demilitarized Zone in northwestern South Vietnam. This operation began on 22 January 1968, and by 24 March, 344 sorties had been flown in support of the emplacement and monitoring of mines and sensors in the Khe Sanh area. During this period, a total of 2,406 target sequences were sensor-generated; 2,378 of these were passed to the ABCCC, and 2,377 to the Marines at Khe Sanh for possible artillery strikes. ABCCC reports indicated strikes on 471 of these targets; and though it was difficult to get consistent and accurate reports from the beleagured Marines defending Khe Sanh, they verified 136 of the target coordinates had been taken under artillery fire. Many more strikes undoubtedly went unreported.[7/]

Although use of this system to detect and attack enemy ground forces already deployed in a battle area was not a part of the planned interdiction function, it may have contributed substantially to reducing the enemy's capability to sustain his siege and to launch attacks against the combat base. It proved, too, that sensor fields and munitions could be planted, maintained, and monitored under difficult combat conditions in a hostile area, and could

gather timely information on possible enemy troop movements, which was inaccessible by other means.

7AF Plans for Revised Use

As a result of analyses of the MUSCLE SHOALS program in the MUD RIVER (antivehicular) area, chiefly by a team of analysis and operational personnel under the guidance of Dr. Robert N. Schwartz, Seventh Air Force, late in March, procedures for using data generated by the sensor fields were to be revised. The change involved using the Infiltration Surveillance Center to analyze truck movement patterns in the MUD RIVER area, and to identify only the more substantial truck concentrations, rather than individual targets as in the past. The ISC would then request the ABCCC to exploit these targets using, if necessary, ground alert aircraft, which would be instantly ready to respond to any lucrative target requests.

The procedures would result in fewer recommendations by the ISC to the ABCCC, but it was expected that the additional time which the analysts at ISC would have to evaluate terrain, weather, and overall truck activity would make their target evaluations more accurate and lucrative. It was planned to provide continuous air coverage of the MUD RIVER area during periods of maximum enemy truck movement, in addition to the ground alert by A-26 aircraft based at Nakhon Phanom.[8/]

In a message to CINCPACAF on 3 April 1968, Seventh Air Force announced the new procedures would begin in "early April", adding that the number of individual TFA recommendations would probably be "sharply decreased". The message pointed out that "even with the worsening weather conditions in

MUD RIVER...immediate explorations of this nature in MUD RIVER are important to future use of MUSCLE SHOALS in other areas."[9]

At the end of March 1968, the introduction into the MUSCLE SHOALS system of more flexible and sophisticated equipment was being planned. New seismic and acoustic sensors, which could be turned on and off at electronic command, and new sensing devices using magnetic, infrared, ultraviolet, and even olfactory detecting mechanisms were in various stages of testing. This improved equipment, which would make possible better control of the sensor fields after emplacement, was collectively known as Phase II of the IGLOO WHITE program; it was expected to be ready for service during the summer of 1968.[10] It appeared likely at the end of March 1968, the purely technical feasibility of the system would be firmly established, but it also appeared that tactics of employment and operational use of the system had yet to be explored and determined.

Conclusions and Questions

Although no definitive conclusions have been formed in this study on the operations of MUSCLE SHOALS, answers to questions such as these could play a vital role in the ultimate usefulness of the MUSCLE SHOALS system:[11]

- To what extent should the system in isolation, have control over its own aircraft resources for implanting sensor fields and verifying detected target sequences?
- To what extent should the system have direct control over strike aircraft and ordnance in its zone of operation?
- Can the system operate effectively as a real-time intelligence source for predicting future positions of moving targets?

- Can the system be used as the basis for a fully organized Tactical Air Control System (including radar) to monitor and strike enemy traffic and targets both on the surface and in the air within its zone of operations?

- Can the system be used effectively as a basis for defending battlefield strong points? Ground installations? Air Fields?

- Can the system provide accurate guidance for the effective direction of ground or offshore naval fire on ground targets?

- Can the system be used to monitor such areas as demilitarized zones or truce lines?

- Can the functions of sensor monitoring be performed by drone aircraft? By satellites in stably positioned orbits relative to movement of the earth?

- Can the collection and analytic equipment needed to identify targets be installed in movable surface vans or aircraft, so that the system will not be dependent upon a fixed ground installation?

From its inception, MUSCLE SHOALS elicited many types of questions, and if some of these seem visionary, it is worth observing that the program itself was visionary. From its outset, it combined extremes of the technically sophisticated with the amazingly primitive. How would an ordinary, reasonably educated layman, for instance, be likely to react when told of a system that proposed to detect enemy troops moving along jungle trails, by using modern electronic acoustic detectors, which had to be activated by the detonations of firecrackers which the troops were expected to step on? Yet, it must be remembered that this report covers only the stone age of what may be a long era of development.

MUSCLE SHOALS has taxed vast resources of imagination and ingenuity as well as of men and materiel. The Air Force has had a greater hand in developing it, in testing it, and in using it than any other service to date. It therefore appears only prudent for the Air Force to extract from MUSCLE SHOALS all the operational benefits it is capable of producing.

FOOTNOTES

CHAPTER I

1. (TSNF) MUSCLE SHOALS Progress Rpt, Directorate of Management Analysis, Comptroller of the AF, AFXOP, 560-68, LIMDIS, 19 Mar 68, pp. i-iv.

2. Ibid.

3. (TSNF) Anti-Infiltration System Technical Design and Development Plan (S), Part I; System Concept, Design and Deployment (U), DCPG, 25 Oct 67, p. 5. (Hereafter cited: DCPG Program Plan.)

4. Authority appointing McBride to head TFA.

5. (TSNF) DCPG Program Plan, p. 1.

6. Ibid.

7. (TSNF) OPLAN 481-68, 7AF, DYE MARKER, Annex B, 10 Aug 67, p. B-1.

8. Interview by Col Jesse C. Gatlin with Col Garland Fory, 7AF, TACM, 12 Mar 68.

9. OpOrd 515-68, 7AF, MUSCLE SHOALS, Oct 67 (Changed by Amendments), 28 Nov 67.

CHAPTER II

1. (TSNF) DCPG Program Plan.

2. OPLAN 481-68, 7AF, DYE MARKER, Concept of Operations, Annex B, 10 Aug 67.

3. (TSNF) Msg, CINCPACAF to CINCPAC and CSAF, DOP Summarization of Command, Control, and Deployment Problems, PR 020921Z Nov 67. (CHECO Files, 7AF.)

4. (TSNF) Msg, TFA to Air Attache, Vientiane, LIMDIS, 0271140Z Jan 68. (CHECO Files, 7AF.);
   (U) Article, "The Dropouts, Newsweek, 1 Apr 68, p. 33; News Story, AP, Saigon, Bangkok World, 20 Mar 68, p. 1.

5. Briefing, presented to Brig Gen Robert P. Keller, USMC, by Brig Gen W. P. McBride, Nakhon Phanom, Thailand, 23 Mar 68.

6. Ibid.

7. (TSNF) Msg, TFA to Air Attache, Vientiane, LIMDIS, 027114OZ Jan 68. (CHECO Files, 7AF); Msg, 7AF to U.S. Embassy, Vientiane: (P) 22/1355Z Dec 67; Msg, 7AF to U.S. Embassy, Vientiane, (P) 16/1002Z Dec 67.

8. Interview, Sensor Management, with Maj Richard A. Szulborski, ISC, Nakhon Phanom, Thailand, 23 Mar 68.

9. Ibid.

10. Interview (Planning Meeting), with Col John E. Madison, Director of Operations of TFA, ISC, Nakhon Phanom, Thailand, 23 Mar 68.

11. Briefing Notes, TUOC, Nakhon Phanom, by Writer, Col J. C. Gatlin, 24 Mar 68.

12. Ibid.

13. Briefing, presented to Brig Gen R. P. Keller, USMC, by Brig Gen W. P. McBride, Nakhon Phanom, Thailand, 23 Mar 68.

14. Interview with Capt Michael E. Harlan, Photo Intelligence Officer, TFA, 22 Mar 68.

15. Briefing, presented to Brig Gen R. P. Keller, USMC, by Brig Gen W. P. McBride, Nakhon Phanom, Thailand, 23 Mar 68.

16. Interview, with Maj Robert A. Morris, Jr., TFA Operations in ISC, Nakhon Phanom, 23 Mar 68.

17. Personal Observations, Briefing, and on Mission with EC-121, orbiting over DUMP TRUCK area, Night of 26-27 Mar 68.

18. Ibid.

19. Ibid.

20. Personal Observations, Plotting Rm, ISC, Nakhon Phanom, Thailand, 22-24 Mar 68.

21. Briefing, Brig Gen R. P. Keller, USMC, by Brig Gen W. P. McBride, Nakhon Phanom, Thailand, 23 Mar 68.

22. Ibid.

23. Briefing, presented to Lt Gen Albert T. Clark and his party, by Brig Gen W. P. McBride, ISC, Nakhon Phanom, Thailand, 24 Mar 68. (Hereafter cited: Briefing presented Lt Gen A. T. Clark.)

24. Interview, with Maj Richard A. Szulborski, Sensor Mgmt, ISC, Nakhon Phanom, Thailand, 23 Mar 68.

25. Briefing presented Lt Gen A. T. Clark.

26. Ibid.

27. Ibid.

28. Ibid.

29. Ibid.

30. Ibid.

31. Interview, with Maj Richard A. Szulborski, Sensor Mgmt, ISC, Nakhon Phanom, Thailand, 23 Mar 68.

32. Personal Observations by Writer, Col J. C. Gatlin, ISC, 22-26 Mar 68.

CHAPTER III

1. Interviews with Officers, MUSCLE SHOALS Program, 7AF Hq; TFA; Ops Base, ABCCC, Udorn RTAFB, Thailand, Mar 68.

2. Briefing presented Lt Gen A. T. Clark.

3. Ibid.

4. (S) Working Paper 68/1-1, Special Combat Analysis Div, Directorate of Tactical Analysis, 7AF Hq, "STEEL TIGER (Laos) Monthly Interdiction Analyses (MUSCLE SHOALS)", 1 Mar 68.

5. Ibid.

6. Ibid.

7. Briefing presented Lt Gen A. T. Clark.

8. Interview with Dr. Robert N. Schwartz, 7AF (COA), 15 Apr 68.

9. Msg, authenticated by Dr. Robert N. Schwartz.

10. Briefing, Brig Gen W. P. McBride, by Maj Russel B. Ives, ISC, Nakhon Phanom, Thailand, 23 Mar 68.

11. Interview with Lt Col John G. Ironmonger, 7AF, 11 Apr 68.

APPENDIX I

MUD RIVER ANTIVEHICULAR AREA

	1-31 Dec	1-31 Jan	1-29 Feb	1-24 Mar	Totals
Initial targets generated	960	1,096	608	756	3,420
Updated information on initial targets	+330	+159	+68	+87	+644
Total sequences generated	1,290	1,255	676	843	4,064
Sequences not passed to ABCCC	-58	-27	-4	-11	-100
Sequences passed to ABCCC	1,232	1,228	672	832	3,964
Targets confirmed	141	79	183	43	446
Actions reported by ABCCC on sequences which were confirmed:					
Strike action	133	59	152	26	370
Visual contact - no strike	8	20	31	17	76
Total confirmed targets	141	79	183	43	446
ABCCC reports on remaining sequences:					
No visual contact	677	440	234	247	1,598
No ABCCC action	414	709	255	542	1,920
Total unconfirmed sequences	1,091	1,149	489	789	3,518

APPENDIX II

TARGET DATA

	Dec 67	Jan 68	Feb 68	1-24 Mar 68
Number of ISC Requests visually confirmed (Percent of total requests)	112 (8.7)	83 (6.8)	188 (27.6)	43 (5.2)
Number of confirmed targets attacked (Percent of confirmed targets attacked)	103 (92)	43 (60)	130 (69)	26 (60)
Results for MUSCLE SHOALS Targets: (Total results in MUD RIVER area)				
Trucks Destroyed	97 (574)	61 (641)	111 (499)	(NOT AVAILABLE)
Trucks Damaged	16 (177)	12 (136)	13 (104)	
Secondary Explosions	98 (1,588)	17 (1,805)	155 (630)	
Secondary Fires	116 (1,246)	121 (1,354)	188 (848)	

GLOSSARY

ABCCC	Airborne Battlefield Command and Control Center
Acoubuoy	Acoustic Intrusion Detector
ADSID	Air Delivered Seismic Intrusion Detector
BB	Button Bomb
DCPG	Defense Communications Planning Group
DT	Dragontooth Mine
FAC	Forward Air Controller
FADSID	Fighter Aircraft Delivered Seismic Intrusion Detector
Gravel	Explosive mine capable of injuring personnel and immobilizing trucks
HANDSID	Hand Delivered Seismic Intrusion Device
HELOSID	Helicopter Delivered Seismic Intrusion Device
IOC	Initial Operational Capability
ISC	Infiltration Surveillance Center
MSQ-77	A radar-bombing director system
RTAFB	Royal Thai Air Force Base
SAM	Surface to Air Missile
SEA	Southeast Asia
SL	STEEL TIGER
TACC	Tactical Air Control Center
TACS	Tactical Air Control System
TAO	Target Assessment Officer
TFA	Task Force Alpha
TUOC	Tactical Unit Operations Center
VHF	Very High Frequency